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# **RAISING FINANCE TO SUPPORT DEVELOPING COUNTRY ACTION: SOME ECONOMIC CONSIDERATIONS**

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## **Abstract**

This article explores the principles that should guide efforts to raise finance for climate action in developing countries. The main conclusions are that, first, there is an important role for private finance, which would be facilitated by having pervasive and broadly uniform emissions pricing around the world. Second, public finance is warranted by a range of market – and policy – failures associated with climate change and its mitigation. Third, raising tax revenues may be preferable to borrowing as a means of raising public finance, although the economics is not clear-cut. Public finance theory advocates taxing ‘bads,’ of which a number have escaped the tax base so far. But it discourages hypothecation of specific revenue streams to particular uses. Fourth, how much could or should be raised by the many specific proposals for finance for climate action in developing countries is often uncertain. So is how multiple schemes would interact. Several schemes could depress carbon prices. Earmarking is often assumed to be justified despite the arguments to the contrary. Fifth, two sets of proposals do particularly well judged against this analysis: (i) expanding the scale and scope of the CDM (ii) expanding the use of international financial institutions’ balance sheets.

**Keywords: financial mechanisms, economic assessment, less developed countries,  
hypothecation**

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## 1. THE FINANCING CHALLENGE

Arresting human-induced climate change requires global action to reduce greenhouse gas (GHG) emissions sharply. To have a 50% chance of keeping the global mean temperature increase below 2°C, global emissions have to fall by between 2.5% and 3% per year on average between 2010 and 2050 (Bowen and Ranger, 2009).

Developing economies<sup>2</sup> now account for well over half of global emissions and their share is growing relative to that of developed economies,<sup>3</sup> so if the 2°C ceiling is not to be exceeded, they will have to start reining in their emissions soon (Clarke et al, 2009). And as climate change is likely to hit poorer countries sooner and harder than it will hit developed nations, the former will have to undertake a disproportionate amount of adaptation. A wide range of ethical frameworks suggest that developed countries should finance a significant share of the necessary spending on mitigation and adaptation in developing nations – 100% according to some value systems.<sup>4</sup>

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<sup>2</sup> Defined as non-Annex 1 countries under the Kyoto Protocol.

<sup>3</sup> Defined as Annex 1 countries under the Kyoto Protocol. The 47 countries in the UNFCCC's category of Least Developed Countries, in contrast, accounted for just over 4% of emissions and their aggregate emissions had been growing at an average 1.5% per year – a reminder that developing countries are by no means a homogeneous group as far as emissions are concerned.

<sup>4</sup> Different ethical frameworks point to different allocation schemes in global cap-and-trade proposals, as illustrated by Höhne et al, 2005. But virtually all entail large transfers to developing countries. A more general discussion of the interaction of economics, ethics and climate change can be found in Dietz et al, 2009.

Reflecting this consensus, developed countries have agreed, as part of the United Nations Framework Convention on Climate Change (UNFCCC), to cover the “agreed full incremental costs” of implementing mitigation measures and to “assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation.” These commitments have been reiterated in the Kyoto Protocol, the Bali Action Plan and the Copenhagen Accord, with the latter setting a goal for developed countries to mobilise jointly US\$ 100 billion a year by 2020 “to address the needs of developing countries.”

This agenda raises several questions considered further below. First, what should the balance be between private and public sources of finance? Second, how can private sources of finance be generated? Third, how should public funds be raised by individual governments and by international collaboration? This article discusses the criteria that economic analysis suggests. Fourth, it asks, how do specific proposals rate according to these criteria and others? The article concludes with the hope that governments will act speedily to fulfil the promises of the Copenhagen Accord but without neglecting the principles of public finance in the process.

## **2. PRIVATE AND PUBLIC SOURCES OF FINANCE**

The simple textbook prescription to deal with the greenhouse gas externality, a global cap-and-trade system with appropriate allocation of tradable emissions quotas across individuals, countries and time, would entail a reliance on private sources of finance. It would generate a world price for emissions, so that private agents would internalise the externalities they cause. The lump-sum transfers across individuals necessary to

correct any adverse distributional impact from the imposition of a price and the residual climate damages would be achieved by appropriate allocation of quotas. The allocation could also be used to compensate those who had to spend proportionally more on adaptation.<sup>5</sup> Private finance flows would be generated entirely in emission reduction markets. Local investments in mitigation and adaptation would be financed by private agents in the developing countries themselves, with the help of their share of revenues from those markets and guided by the changes in relative prices over products and across time induced by the carbon price.

However, this prescription is highly unrealistic. In practice, the problem of the GHG externalities is compounded by several other market failures, many of which need to be tackled by public policy. There are also public policy failures, such as the lack of credibility of the policy framework that can arise when governments cannot bind their successors. Where climate-change action in developing countries involves these externalities, financial support from developed nations is likely to have to involve public finance. Also, emission reduction markets cannot be relied upon to deliver resources to all those who need to make climate-related investments, particularly those required for adaptation. If projects in developing countries need to raise private finance abroad, they must be able to offer an expectation of an appropriate risk-adjusted return, which in many cases they will be unable to do without public support, given the administrative costs and other obstacles.

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<sup>5</sup> The second fundamental theorem of welfare economics states that, under certain (rather restrictive) conditions, every Pareto-efficient allocation of resources can be achieved by a competitive market equilibrium. When it holds, the problems of efficiency and distributional impacts across individuals can be separated (Varian, 2009). If introducing emissions pricing to correct the inefficiency induced by the GHG externality has adverse distributional consequences, these can be corrected by lump-sum transfers, set to ensure that at least someone is better off after the pricing is implemented while no-one else is made worse off. The point here is not to rehearse the restrictiveness of the assumptions necessary for the theorem to hold (complete markets, perfect competition, etc), but to emphasise that in this framework lump-sum transfers are necessary for the introduction of emissions pricing to be unambiguously welfare-enhancing.

One key market failure affects innovation. Many types of knowledge have the characteristics of a public good – one firm using an idea does not prevent another firm from doing so. That tends to lead to underinvestment in the creation of knowledge. Hence public subsidies to such activities are warranted, including to climate-related R&D tailored to the needs of developing countries. The public sector can redirect technological progress by supporting development of low-carbon technologies that have not benefited from extensive experience. But the initial costs of adopting a low-carbon development path will be higher, underlining the need for early public intervention to reduce emissions cost-effectively over time. And there are numerous problems arising from inadequate and unevenly distributed information, which the public sector may be able to help solve by collecting and disseminating knowledge that would be under-provided by the private sector.

Another important source of market failure is the existence of network externalities: an enterprise joining a network does not take into account the benefits that accrue to others from the expansion of network membership. Without public intervention, the market initially underinvests in expanding the network. Hence public support is likely to be necessary for the development of network infrastructure in developing countries, notably in energy distribution. It may be easier for the public sector to set up the network rather than to calibrate and apply the appropriate initial subsidies to stimulate private provision.

The malfunctioning of financial intermediation is another obstacle to adequate private flows of finance. Without political stability, regulatory certainty and administrative

simplicity, perceived risks can undermine incentives to invest in projects with large up-front costs (as is typical of many mitigation projects<sup>6</sup>). That can make projects that appear to pass cost-benefit tests unattractive in practice. And when private-sector financial intermediation is impaired (as it is at the moment) by reduced risk appetite, heightened doubts about counterparty solvency and increased uncertainty about asset valuations, the public sector may be able to act as a financial intermediary of last resort. In some developing countries, financial intermediation is rudimentary or non-existent, partly because of the low levels of income.

A further reason for public-sector support for developing country actions is to demonstrate the commitment of developed-country policy-makers to announced policies, thus building credibility and strengthening the impact of incentives to alter private-sector behaviour. Policy commitments that include financial or reputational incentives for all participating governments to achieve announced outcomes can enhance the credibility of the policies and help to align the interests of policy-makers more closely with those of private agents. Thus public support for developing-country actions, especially through multilateral frameworks endorsed collectively by all participating governments, can help to strengthen actions by the private sector.

At present, with the credibility of international endeavours to achieve a global deal on climate change in question, uncertainty about the global climate policy regime after 2012 increasing, firms in developed countries still cautious about investing and private trade and capital flows still impaired, support for developing countries' actions in the near term is likely to have to be much more reliant on public funding than in the

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<sup>6</sup> Thus private finance is likely to be easier to raise for project operation, where revenues and costs are more closely aligned in time, than for capital investment, unless there is public intervention.



future. And pervasive market failures, together with the inability of dealing with international income distribution impacts simply with global quota allocations, justify some public component continuing in the long term. But if global carbon markets can be developed further and their long-term credibility underpinned, the contribution from private funding could be much more substantial. Such a contribution might also be less subject to the changes of political will and time inconsistency of policy-makers, which have led to considerable scepticism about the reliability of developed countries' pledges on development aid.

The sources of finance for adaptation are likely to be somewhat different from those for mitigation. Private economic agents will generally be in a better position than public authorities to assess most adaptation needs, given their variety and specificity to particular locations (although some infrastructure investment is likely to require more government involvement). Many adaptation investments will be small-scale and likely to be financed through conventional private means. The challenge is to design mechanisms to distribute flows of public finance to support the incomes of those with the greatest adaptation needs and to help them with the costs of private finance.

### **3. GENERATING PRIVATE FINANCE**

Economists have debated at length the merits of emission reduction markets relative to emissions taxation.<sup>7</sup> The former approach ensures that, once negotiators have agreed on how the markets are to function and how property rights are to be assigned, private flows of funding are generated. Developed-country governments do not have

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<sup>7</sup> See, for example, Nordhaus (2007), who makes a trenchant case for carbon taxation in preference to global quotas, and Metcalf (2009).

to continue to redress the distributional impacts of climate-change mitigation policies, with the danger of reneging when public budgets are under pressure or particular recipients of financial flows become unpopular. Some see this as an advantage of a markets-based approach compared with a ‘taxation and transfers’ regime under which developed countries make explicit transfers of public tax revenues to developing countries.<sup>8</sup> However, a markets-based approach may be more susceptible to lobbying and capture by special interests. Domestically, firms may lobby for free allocation of quotas, for example, by ‘grandfathering’ allocations. That can inhibit competition and reduce the tax base of governments, making public transfers to developing countries more difficult to finance. A global cap-and-trade scheme would also be likely to generate more rents for fossil-fuel exporters, whereas coordinated carbon taxes would allow domestic governments to capture the rents from carbon pricing. The impact on international income distribution could undermine developed-country support for the carbon pricing regime, although it might be a necessary part of binding in fossil-fuel exporters to any global deal on climate-change policies.<sup>9</sup>

A key objective of a markets-based approach should be to internalise the GHG externality, which entails GHG pricing: ‘getting prices right.’ In real-world schemes, different carbon instruments such as quotas within the EU Emissions Trading Scheme, Clean Development Mechanism credits or auction prices for Assigned Amount Units, trade at different prices. Some of these differences may reflect other characteristics of the instruments, but policy-makers need to consider whether the

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<sup>8</sup> Stern (2009) is an example. Frankel (2009) is another analysis that is sympathetic to the markets-based approach behind Kyoto.

<sup>9</sup> I am grateful to an anonymous referee for raising the issue of fossil-fuel exporters. Aggressive mitigation policies are likely to lower the value of their resources and may depress (carbon-price-exclusive) fossil-fuel prices. To avoid Sinn’s ‘green paradox’ according to which climate-change policies may accelerate emissions (Sinn, 2008), it is important that they participate in any global deal. What side payments might be required is a moot point.

proliferation of carbon instruments is providing a blurred signal to potential providers of private finance.

Perhaps more importantly, it is unlikely that the appropriate level and direction of private finance to developing countries will be ensured without domestic emissions prices (implicit or explicit) at levels broadly comparable across countries, both developed and developing. Fossil-fuel subsidies, for example, will discourage private investment in low-carbon technologies and the absence of emissions pricing can encourage funding for investments that result in ‘carbon leakage’ from countries that do impose a carbon price.

Private investors are concerned about carbon prices over time. There is a role for policy-makers in reducing the uncertainty about future prices facing private agents, not least because it partly reflects uncertainty about policy-makers’ future behaviour. Thus private finance flows will be encouraged if the international policy framework and the rules and regulation of carbon markets are settled, clear and credible for the long term. The design of such markets should also discourage price volatility (for example, by allowing banking – and perhaps borrowing – in Emissions Trading Schemes and ensuring liquidity and competition in carbon markets).

As argued above, public finance may be necessary to leverage private finance. It might include grants, interest-rate subsidies for private-sector project-finance, loan guarantees and insurance premia to help manage the risks unique to climate-change-related investments. Innovations like the Green Investment Bank proposed in the United Kingdom have considerable potential to help unlock private finance flows. So

do the project finance vehicles that public bodies such as the international development banks have experience in building. The public sector can also increase the long-term credibility of climate policies by devices such as equity co-investment and the issuance of indexed bonds that pay more when carbon prices fall, hence allowing carbon market participants to hedge their risks more easily. The crucial requirement at this stage in the evolution of the international policy regime, given the economic environment, is for public institutions to help ‘de-risk’ investment opportunities for the private sector. But it should also be noted that carbon markets can generate considerable rents from cheap abatement opportunities, which can lead to very generous private returns to compensate for the risks involved.<sup>10</sup>

#### **4. RAISING PUBLIC FINANCE**

Public finance theory, as articulated for example in Atkinson and Stiglitz (1980), Musgrave and Musgrave (1989) and Kay (1990), gives guidance as to how public finance for supporting developing countries’ actions should be raised.

First, public authorities have a choice between raising taxes (or fees and user charges) and borrowing. The general principle is to tax to finance current spending and borrow to finance public investment; the social return on the investment should be expected to exceed the cost of raising funds (Blanchard and Giavazzi, 2004; Ismihan and Ozkan, 2008). From the perspective of a developed-country government, that suggests that transfers to developing countries should be financed by tax revenue. But there is some ambiguity if the developing country uses transfers to invest in mitigation and

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<sup>10</sup> Concern about the size of rents on intramarginal abatement opportunities has led to various proposals for price discrimination in carbon markets, not least with respect to the treatment of abatement opportunities in forest management.

adaptation that will pay off in the future; should the developed country count that as part of its own social return?

If the case for countercyclical deficit financing by governments is accepted, that justifies a greater share of borrowing, but only in the downturn of the business cycle; an ‘exit strategy’ to substitute other funding sources is necessary if the associated spending is to continue during recovery.<sup>11</sup> Another justification for more borrowing is if the government is in a better position than banks to act as a financial intermediary, for example because there are risks that can be better assessed and managed in the public sector – one of the arguments in a domestic context for public-sector sponsorship of ‘green’ investment banks (e.g. Green Investment Bank Commission, 2010).

Second, taxes should be levied on ‘bads’ such as emissions and congestion (Pigovian taxes; Pigou, 1932) and, where revenue requirements exceed what can be raised by taxing ‘bads’, ‘goods’ in more inelastic supply should be taxed more heavily. That points to the desirability of working out how to tax ‘bads’ that are currently escaping the fiscal net.<sup>12</sup>

Third, taxes raise questions of equity as well as efficiency. Hence the ultimate incidence of new taxes needs to be considered and, if necessary, the welfare system adjusted to compensate losers. In practice, that is often difficult without changing incentives and thereby affecting economic efficiency. As a result, governments often

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<sup>11</sup> The relationship between environmental policy and business cycles is discussed in Bowen and Stern, 2010.

<sup>12</sup> Unfortunately, governments are often better at identifying goods that they should subsidise because of the presence of market failures than they are at identifying untaxed bads. But revenues from environmental taxes are surprisingly low in many countries (European Commission, 2008 and 2010a).

prefer to finance new obligations by raising tax revenues across the board, so that the incidence of the tax system is unchanged, on the assumption that it already broadly reflects distributional preferences and efficiency considerations.

Fourth, traditional public finance theory frowns on hypothecation of revenues from particular sources to particular uses, except when setting a user charge to cover the marginal costs of a publicly provided good (OECD, 1996; McCleary, 1991). With the latter exception, there is no reason why the revenue generated by the appropriate tax rate on one activity (e.g. global financial transactions) should equal the appropriate spending on another activity (e.g. public support for developing countries' climate policies). Even if tax rates and spending are initially set so as to bring about the equality needed, there is no guarantee that they will remain so over time.

The same is true with many activities that are apparently related to each other. For example, there is no reason why the revenue from an optimal global carbon tax should equal the optimal spending on adaptation and mitigation at the chosen target level of GHG concentrations in the atmosphere. Indeed, the 'double dividend' literature<sup>13</sup> is predicated on the possibility that revenues from carbon taxation (or quota auctions) could also be used to reduce distortionary taxes, such as payroll taxes, elsewhere in the economy. The efforts to set different carbon prices for intramarginal mitigation (e.g. by establishing lower carbon prices for avoided deforestation than for electricity generation) suggest that policy-makers suspect that uniform carbon pricing could raise revenues well in excess of mitigation needs. The mere fact that two activities are

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<sup>13</sup> This literature is extensive and represents perhaps the richest strand of discussion of public finance issues in the climate-change policy arena. See, inter alia, Bovenberg and Goulder (2002) and Schöb (2003).

climate-related does not justify earmarking the revenues from taxing one of them for spending on the other.

Some have argued that hypothecation is likely to make it easier to ensure that funds raised are additional to previous commitments by developed countries (Müller, 2008; Oxfam, 2008). But finding a new source of revenue and then earmarking it does not prevent the earmarked spending from displacing spending, financed from other sources of tax revenue, on the same objectives. Additionality is not guaranteed by how the funding is raised (Landau, 2003).

Pirttilä (1998) has advanced a more sophisticated argument for hypothecation: hypothecating the revenues from environmental taxation to the provision of public goods that benefit the losers from the environmental policy may improve welfare (compared with lump-sum transfers) if governments do not have enough information to discriminate more carefully among the losers. That provides some justification for allocating the revenues from carbon taxes or quota auctions to public goods benefiting those hit hardest by carbon pricing. But it does not justify earmarking revenues from non-climate-related sources to climate actions, nor revenues from climate-related sources to mitigation that does not primarily benefit those affected most by carbon pricing.

Brett and Keen (2000) offer a more political explanation for hypothecation, showing how a 'green' incumbent government may choose to earmark revenues if the efficiency loss from doing so is outweighed by the value of constraining subsequent and potentially 'non-green' policy-makers from diverting the funds raised. Hence

hypothecation can be seen as a device to discourage back-sliding. It is a moot point whether policy-makers at present are likely to be greener than their successors. If so, that does not bode well for the long-term credibility of the international climate policy framework.

Where specific sources of finance are hypothecated, given the drawbacks of earmarking, it is necessary to consider whether the revenue raised will over time meet either a specific financial target (such as the Copenhagen Accord's US\$ 100 billion per year) or, more generally, the equitable share of developing countries' evolving climate action needs.

Fifth, public finance theory flags the importance of administrative costs, including compliance and monitoring costs, so it is helpful to consider whether proposals entail new administrative burdens or use the most efficient existing tax-raising and disbursement channels. Taxes applied to a broad base but at low rates are attractive in this respect to keep tax avoidance activities low.

International collaboration among developed-country governments is desirable in delivering public finance flows where these reflect obligations taken on in the context of international negotiations or where economies of scale in monitoring, verification and reporting are important. But that does not imply that co-ordination of revenue sources is necessary. Governments may agree about the appropriate uses of funds without agreeing about appropriate sources. The exception to this principle is when new tax instruments are found to be desirable but would have cross-border implications, as with the taxation of, for example, cross-border pollutants, activities



outside individual countries' jurisdictions and cross-border financial transactions. In such cases, the distributional implications of the new tax would have to be considered as well as the modalities of levying it.

## **5. SOME SPECIFIC PROPOSALS**

There have been many specific proposals as to how to help finance developing-country action on climate-change mitigation, adaptation and related capacity building, technology transfer and development. This section considers several briefly in the light of the discussion above. It also offers a preliminary assessment of the recommendations of the UN Secretary-General's High-Level Advisory Group on Climate Change Financing, which reported in November 2010.

Most of the proposals entail raising public finance from particular sources, raising two key questions. First, is hypothecation warranted in the case in question? One test is to compare the proposed measure with raising finance through a general increase in domestic tax revenues by developed-country governments. Second, collectively, is the balance right between public and private sources of finance?

Other criteria suggested by the discussion above include: is the scale of funds raised appropriate? If so, will it remain so? In other words, is it reliable? Given the likely administrative burdens (e.g. for tax enforcement, record-keeping and monitoring use), is the proposal practical and cost-efficient? Is the ultimate incidence of the tax or interest burden appropriate, given the ethical framework(s) invoked to justify the generation of new finance in the first place? Does the proposal assure that funds

raised are additional to obligations to developing countries previously acknowledged by developed countries? And, in the language of the Copenhagen Accord, does the proposal ensure that financial flows take place “in the context of meaningful mitigation actions and transparency on implementation?”

### ***Expanding the use of carbon markets***

Several proposals have involved stimulating climate-related finance flows by extending the scope of carbon markets, primarily by expanding the scope of the Clean Development Mechanism (CDM); less emphasis has been placed on extending the number of countries using cap-and-trade systems with offsetting. The CDM allows projects in developing countries that achieve emissions reductions (relative to an appropriate baseline) to generate Certified Emission Reductions (CERs) that can be used by Annex 1 countries to meet their national emission caps. Private firms can purchase CERs to satisfy liabilities under domestic emission trading system caps; but governments can also buy CERs to meet their Kyoto Protocol caps or to provide climate finance. According to UNEP, nearly 1 billion CERs will have been issued by the end of 2012.<sup>14</sup> The UNFCCC has suggested that annual flows of US\$ 15 - 20 billion are possible while the European Commission suggests €38 billion. And, as Hepburn (2009) points out, explicit CERs from the CDM (together with Joint Implementation) have probably leveraged ten times as much in overall investment from the private sector.<sup>15</sup>

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<sup>14</sup> UNEP Risø Centre website, accessed 24 August 2010

<sup>15</sup> Developed-country investors often sign emission reduction purchase agreements that involve payments at an early stage in the CDM project (often before it is registered) but at a price below the market price for CERs. Thus the funding provided differs in timing and amount from the market value of the CERs generated.

The CDM has been criticised over bottlenecks and transactions costs. Serious questions have also been raised over assessments of the additionality of proposed emissions reductions. There is also the broader question of whether the lack of explicit carbon pricing in the countries eligible for the CDM has encouraged sufficient ‘carbon leakage’ to outweigh any contribution to mitigation from the CDM (for example, by displacing to developing countries the export production of carbon-intensive products that then becomes eligible for CDM credits). But it has the merit of helping to set an implicit carbon price in non-Annex 1 countries (because of the opportunity cost of neglecting emission reduction possibilities), promoting the cost-effectiveness of global mitigation efforts (relative to a world in which CDM-eligible countries had no incentive to mitigate) and demonstrating a track record of some success. It also encourages decentralised private finance flows to developing countries.

Proposals have therefore been made to scale up the CDM by increasing its scope beyond individual projects to sectors and emission-reduction programmes in developing countries and by helping more countries participate in the CER markets (China, India, Brazil and Mexico account for a very large share, although not necessarily much out of line with the distribution of incremental investment needs).<sup>16</sup>

The CDM suffers, however, from the mounting uncertainty about what international policy regime will prevail after the end of the 2008-2012 Kyoto accounting period. It has also been disadvantaged by the prospect of the price volatility that afflicts any

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<sup>16</sup> The CDM has been much debated in the context of the evolution of the international climate policy regime. See, for example, Schneider (2007) and papers from UNEP’s centre for Capacity Development for the Clean Development Mechanism <http://cd4cdm.org/index.htm>. The Green Investment Schemes for post-communist Annex 1 countries may provide a useful model for a more flexible CDM (Tuerk et al, 2010).

emissions-quantity-based scheme in the face of macroeconomic shocks. Also, experience suggests that CDM private finance is more attracted to some project types than others – it does well with renewable energy and non-CO<sub>2</sub> GHG abatement, but not so well with energy efficiency and transportation, probably because of the various additional market failures involved in the latter. Another potential problem is that the extension of the CDM to low-abatement-cost options, for example, in forestry, could drive down the price of CERs. One possible response would be the introduction of a new type of offset credit not fully fungible with the CERs. But that would reduce the incentive for developing forest carbon sinks at the margin. If the price of CERs fell too far, that would be a sign that developed country caps were not tight enough and should be brought down.

Overall, expanding carbon markets in general and the CDM in particular looks an attractive option. It stimulates private finance flows, helps to ‘get prices right,’ is overcoming administrative problems and has already been subject to much useful scrutiny. Monitoring, verification and reporting are already a central concern.

Hypothecation is justified if one believes that the level of emission reduction targets assigned to Annex 1 countries is appropriate given the required reduction in global emissions by 2050 and ethical perspectives on equity across countries. The scale could be big enough at least to address developing countries’ mitigation needs. But the precise size of flows is difficult to predict, depending on, among other factors, emissions prices in developed countries and the offset rules they adopt. National and international climate policy regimes have to ensure that demand for offsets rises along with their supply or, in other words, that effective carbon prices are kept high enough to match the level of global ambition for climate-change mitigation.

### *Multilateral proposals: climate-related sources*

#### (i) International auctioning of emission quotas

Proposals have been made for the proceeds of auctions of emissions quotas to be earmarked for climate action funds, thus using another climate-related source of finance. Norway has suggested some Assigned Amount Units (AAUs) could be auctioned by an international body (using Kyoto Protocol mechanisms) instead of issued to individual countries, with funds going to support climate action in developing countries, including support for their Nationally Appropriate Mitigation Activities (Center for Clean Air Policy, 2009).

This category of proposals could generate substantial finance flows; a sale of 2% of AAUs could raise US\$ 14-25 billion, depending on the price. As with the CDM, it has the benefit of helping to establish an emissions price. And, like the CDM, its revenue prospects depend on having a regime ensuring tight emission caps on Annex 1 countries in the future.

However, under the Norwegian proposal, countries may seek less stringent caps to compensate for some (or even more than) the AAUs auctioned. That would reduce the environmental benefit and lower the price. Second, private entities would need to be able to buy the AAUs and use them for compliance to create a demand for the AAUs (currently installations covered by the EU ETS cannot use AAUs). If the

Russian and Ukrainian AAUs from 2008-2012 were used, that would generate a huge increase in the supply.

(ii) Offset levies

At present, a levy of 2% is imposed on all CDM transactions to help fund adaptation to climate change through the Adaptation Fund of the UNFCCC. WRI (2008) describe this levy as the “iconic but largely untested” example of a truly global financing instrument. It could raise around US\$ 500 million between now and 2012 (Fankhauser and Martin, 2010). The proposals to extend the scale and scope of the CDM, mentioned above, introduce the possibility of raising considerably more through an offset levy of this sort. The possibility of a 3-5% levy and an extension to Joint Implementation and Emission Trading are under discussion. Fankhauser and Martin calculate that, with a broader CDM, a 10% levy could raise US\$ 10 billion a year by 2020.<sup>17</sup>

A major problem with the offset levy is that it is a tax on activities that economic analysis of the Kyoto framework suggests should be encouraged for reasons of cost effectiveness and equity. Thus it is likely to reduce offset transactions and the implicit carbon price facing projects in developing countries. The uncertainty about revenues from the CDM is compounded by the uncertainty about how a higher-rate levy would affect CDM flows. Fankhauser and Martin point out that sellers of offset credits (developing countries) are likely to bear two thirds of the cost of the levy,

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<sup>17</sup> Erik Haites points out that the CDM levy can be interpreted as being imposed on the CERs issued or the CERs traded internationally, since they will all be used in developed countries. The base – issued or traded – makes a huge difference when a levy is to be applied to Emission Reduction Units (ERUs) and AAUs. In the case of AAUs, it would be virtually identical to the Norwegian proposal.

unless buyers in developed countries are subject to supplementarity restrictions i.e. limits on the proportion of their emissions that they can offset abroad. With supplementarity limits, the incidence of the levy is likely to be almost entirely on the buyers. Without supplementarity restrictions, the deadweight loss imposed by the levy rises sharply with the tax rate. One reason why its extension is being discussed may be the ambivalent attitude of many towards offset mechanisms.

(iii) Marine and aviation bunker fuel levies

International aviation and shipping have largely escaped coverage by emissions reduction measures so far (although some air travel fees and taxes have been justified on environmental grounds, such as the UK's Air Passenger Duty). Aviation will be included in the EU ETS from January 2012. Several proposals involving levies on estimated emissions, bunker fuel sales or some other activity measure likely to be correlated with environmental impact have been put forward.<sup>18</sup> Keen and Strand (2007) point out that a fuel tax is more effective in curbing fuel consumption and thus carbon emissions, but a ticket tax has the potential to raise more revenue for climate policies in general and hence may be more useful for financing actions in developing countries.<sup>19</sup> The main proposals are for uniform international implementation by the international regulatory bodies ICAO and IMO for aviation and shipping respectively, probably with exemption from similar domestic regulations. The main problem that remains is compensation for vulnerable island states that would face large increases in transport costs.

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<sup>18</sup> Some useful references include Müller and Hepburn (2006), Faber et al (2010), IMO (2009), ODI (2008) and McCollum et al (2009).

<sup>19</sup> I am indebted to an anonymous referee for alerting me to this argument.

These proposals have the merit of advocating taxes on ‘bads’ that have largely escaped fiscal authorities because of their inherent cross-border characteristics and international governance. As with other climate-related finance sources, some justification for hypothecation can be offered. But revenue streams are uncertain, given uncertainty about the price elasticities involved and about the scope for avoidance. There is a danger that the levies would introduce yet more inefficient variation in carbon prices across industry sectors (unless fully integrated with other international carbon markets) and their interaction with domestic cap-and-trade schemes and other emission reduction measures would have to be considered carefully (the airline industry, for example, has argued that if an international scheme is adopted, airlines should be exempted from domestic policies). However, the amounts likely to be raised are far larger than the current or projected spending of the bodies (ICAO and IMO) that would collect the revenue, so they could commit to a steady stream of funding for climate-related purposes and allow any volatility in revenues to fall on rebates to their members.

***Multilateral proposals: non-climate-related sources***

(i) International financial institutions and funds

A simple way of increasing funding for climate action is to increase the resources available to international financial institutions (IFIs), including the World Bank, the other multilateral development banks and the IMF. The World Bank spent nearly US\$ 3.5 billion on energy efficiency and renewable energy financing in fiscal year 2009 and has pledged capital to the new Climate Investment Funds. The other MDBs



have also been ramping up their climate-related project spending, although this has reflected diversion of existing development assistance rather than additional funding. The EBRD, for example, has specific targets for lending to meet climate policy goals. There are established mechanisms for increasing their capital through contributions by member governments, which can be leveraged to bring in private funds. And they have some experience with developing innovative sources of finance, such as the Advanced Market Commitment for vaccines. IMF staff have proposed a Green Fund that could raise US\$ 100 billion a year by 2020 for climate action finance. The Green Fund's capital could be raised by member countries subscribing some of their Special Drawing Rights (SDRs) quotas, which were recently much expanded in response to the global financial crisis to build up the IMF's ability to lend. That could then leverage private finance through the issue of 'green bonds' guaranteed by members' SDR reserves.<sup>20</sup> However, the IMF's Executive Board has not been enthusiastic about using SDRs in this way. In addition to the IFIs, there are other funds such as the Global Environment Facility and the Adaptation Fund of the UNFCCC, the funding formulae for which could be amended to provide more finance, and new proposals on the horizon, such as the Copenhagen Green Climate Fund proposed in the Copenhagen Accord.

Initiatives along these lines have the advantage of bringing in private finance, either at a 'wholesale' level, with partly private funding of IFI initiatives and multilateral funds, or at a 'retail' level, with IFIs and private finance co-funding specific mitigation and adaptation measures. The approach also (in the case of the development banks) utilises existing project appraisal skills. Expanding the IFIs'

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<sup>20</sup> The IMF proposals are discussed in IMF (2010). Williamson (2009) reviews the economics of SDRs, which are essentially an international form of fiat money. The opportunity cost of using them for a Green Fund would be the reduction in their utility as reserve assets for the subscribing countries.

capital bases would not require the hypothecation of new forms of revenue. Funds would be generated at an appropriate scale. But subscribing countries' contingent liabilities would be increased, as with the SDR proposals. The main questions about such initiatives are more to do with the terms on which funds would be disbursed, such as the extent of concessionality, and the funds' governance.

(ii) Taxes on global 'bads'

Landau (2003) suggests taxing congestion in maritime straits, rights to geostationary orbits and associated radio frequencies and arms sales – activities that generate more clear-cut adverse externalities than do financial transactions. These taxes no doubt have merit on environmental or other social grounds and would probably need to be levied at an international level. But the arguments against hypothecation apply with some force. A tax raised by a supranational body could still be distributed to member nations according to some rule rather than earmarked to some collective international objective. And the sums that would be raised are very uncertain, given that the issue of the optimal tax rates has not been explored.

(iii) Financial transactions taxes

Financial transactions taxes have been proposed as a way of reducing financial instruments' price volatility and the excessive allocation of resources to financial market intermediation (e.g. Schulmeister et al, 2008; Baker, 2008) and can be seen as attempts to tax a social 'bad.' James Tobin proposed a tax on spot foreign exchange transactions to reduce currency speculation and volatile cross-border capital flows as

early as 1972. They could raise significant sums; a tax rate of a mere 1-2 basis points<sup>21</sup> could raise US\$ 15-28 billion (but note that the euro trades against the US dollar with spreads as tight as 1/10th of a basis point). Atkinson (2004) suggested this approach to funding the pursuit of the Millennium Development Goals.

Such taxes suffer from three main drawbacks as sources of funding for climate action. First, the drawbacks of hypothecation are particularly relevant given competing potential uses for international funds of this sort. Second, the amount that could be raised is very uncertain, because the price elasticity of transactions with respect to transactions costs is very uncertain and liable to change according to circumstance (e.g. whether there is a financial panic). Some proposers want to limit the taxed activity while others hope that a very low tax rate would not affect trading volumes significantly. Market liquidity could be impaired, thereby tending to increase volatility. Third, it is not clear that the activities are necessarily bad. Market liquidity and speculation in competitive markets are usually viewed by economists as desirable in helping to update prices quickly in response to new information. Financial transactions taxes are not well designed to correct the underlying market failures that lead to financial crises. Hence recently policy-makers' attention has focused more on imposing additional liquidity and capital requirements on banks, and possibly taxes on some measure of balance-sheet growth, rather than on banks' financial market transactions.

There has been much empirical and theoretical research on such taxes. The evidence does not give grounds for enthusiasm. Hanke et al (2010) provides a brief up-to-date

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<sup>21</sup> A basis point is 1/100 of a percentage point.

discussion of the literature. One problem is that financial transactions taxes can simply become capitalised in the price of the assets traded, so that those holding the assets when the taxes are introduced bear all the costs (see, for example, Saporta and Kan (1997) on stamp duty and equity prices).

### ***Proposals based on national government contributions***

#### **(i) National auctions of emissions quotas**

Some schemes rely on national auctions of allowances with the revenues flowing through national budgets and subject to national policy priorities. Germany allocates part of the revenues from auctions of quotas under the EU Emissions Trading Scheme to its International Climate Initiative. The European Commission proposes extending this practice (European Commission, 2010b). The US Waxman-Markey Act planned to earmark a share of auction revenues from selling US allowances to international use (but probably determined bilaterally with US policymakers, not by international bodies).

The prices for allowance auctions under domestic cap-and-trade schemes, would be broadly similar to those of compliance units in the international market unless the domestic scheme restricts imports or exports of compliance units. Intermittent auctions could contribute to price volatility.

#### **(ii) Carbon taxes**

Switzerland has proposed a tax of US\$ 2 tax per tonne of CO<sub>2</sub> for emissions exceeding 1.5 tonnes per capita, with a share of the proceeds being subscribed to an international climate fund. UNDP calculates that a tax of US\$ 20 per tonne of CO<sub>2</sub> levied by the OECD on its members would raise US\$ 265 billion at current emission levels (Swiss Confederation, 2008). Several countries (e.g. Sweden, Denmark, Norway, Switzerland, Finland) already have carbon taxes on energy consumption, with various exemptions and allowances.

This approach could, with a sufficiently high tax rate, generate a flow of funds on the scale required. The political economy arguments for hypothecation would apply in this case (but the general argument against hypothecation would still have to be considered). As with any ‘green’ taxes, which are designed to reduce the activity taxed rather than simply to raise revenue, there would be some uncertainty about the revenue flows, which would depend on the scope for decarbonisation. One problem is the potential interaction with cap-and-trade schemes. A tax on activities within scope of such schemes would simply depress the carbon price, so it would not have any additional environmental benefit. A tax on activities outside such schemes would introduce multiple carbon prices, inducing allocative inefficiency. The political acceptability of earmarking domestically raised taxes for international bodies at a rate determined outside the country is also in question. A carbon tax, or any other hypothecated source, is at the same time a burden-sharing formula for the contributing countries. Whereas agreement was eventually reached about the distribution of AAUs under the Kyoto Protocol, this instrument would re-open the debate about equity across developed countries.

(iii) Fossil-fuel royalties and subsidies

Earmarking funds raised from fossil-fuel royalties or the removal of fossil-fuel subsidies would also raise national contributions from a broadly climate-related source. Both sources of revenue have some economic justification as sources of general tax revenue. Apart from the objection that, once again, the grounds for hypothecation to action for climate finance are flimsy, this would result in an implicit burden-sharing formula quite different from that agreed under Kyoto and would be likely to run into political opposition. Fossil-fuel exporting countries stand to lose from carbon pricing and are therefore likely to be unenthusiastic about sacrificing further rents from their dwindling natural resources.

(iv) Assessed or indicative contributions

Proposals for assessed or indicative contributions start with an explicit burden-sharing formula and then let governments decide how to raise their contribution, whether with a carbon tax, reduced subsidies, higher royalties, other specific revenue sources or general revenue. That avoids the problem of mandating hypothecation but requires agreement on the overall ambition and the specific formula to be used. In practice, the latter is likely to be very difficult. The USA has been unable to agree to the one implicit in the Kyoto Protocol, perhaps the most obvious candidate. But the approach has been used, sometimes with special provisions for the United States, in cases where financial flows are much smaller than the expenditure anticipated for climate change – the UN operating budget, the UNEP core budget, and the Multilateral Fund of the Montreal Protocol, for example.

***The report of the UN Secretary-General's High-Level Advisory Group on Climate Change Financing (HLAG)***

This report, commissioned at the Copenhagen Conference of the parties to the UNFCCC (COP 15) and published in November 2010, investigated the feasibility of achieving the Copenhagen pledge of US\$ 100 billion a year. It provides a careful review of the scope for raising funds through the types of measures discussed above, at greater length than is practical in this article. The HLAG group potential sources of finance into public sources, development bank instruments, carbon market finance and private capital, assessing each against the eight criteria specified in their terms of reference: revenue-raising capability, efficiency, equity, incidence, practicality, reliability, additionality and acceptability. They conclude that the US\$ 100 billion target is “challenging but feasible” if a variety of measures are taken, to stimulate both public and private financial flows. However, they do not make specific recommendations for action. Like the author of this article, the HLAG stresses that “[i]nstruments based on carbon pricing are particularly attractive because they both raise revenue and provide incentives for mitigation actions.” The economic disadvantages of some proposals are mentioned (e.g. that levies on cap-and-trade offset purchases are effectively a tax on mitigation actions), although the drawbacks of revenue hypothecation are not fully explored.

Two aspects of the report are particularly helpful. First, quantitative estimates of the potential flows from particular measures are compiled on a consistent and transparent basis. Where arbitrary assumptions have to be made, for example about the

proportion of new levies that would be earmarked for climate-change finance, they are laid out clearly and are consistent across instruments. Second, a distinction is drawn between gross and net flows. The latter are likely to be considerably lower than the former, particularly for private capital flows, given that private agents expect a competitive risk-adjusted return on their investments. However, the report makes clear that not all members of the HLAG agreed about how net flows should be calculated or whether the target should be regarded as a target for net additional flows. There was also disagreement about whether private flows should be included. As a result, the report does not provide an illustrative breakdown of how the target can be reached, although it is possible to piece one together from the assessments of individual measures.

This article argues that considerations of equity warrant substantial transfers from developed to developing countries, so that the net basis is the appropriate one to use, notwithstanding the difficulties in estimating net flows. Also, private and public net flows should be considered; private investment can still generate net flows to developing countries because there are intramarginal rents to be captured from mitigation and adaptation investments after deducting a competitive marginal rate of return.

On this basis, the HLAG report suggests that, assuming a carbon price in 2020 of US\$ 20-25 per tonne of CO<sub>2</sub> equivalent, public net flows derived from 10% of domestic carbon taxes or quota auction revenues, new taxes on aviation and maritime emissions and other new levies could amount to US\$ 50 billion per year. Private net investment flows could reach some US\$ 10-20 billion per year and private transactions in carbon



markets could generate US\$ 10 billion per year (a relatively modest amount compared with some other estimates in the literature). Multilateral development banks could stimulate net flows of US\$ 11 billion per year. That leaves some US\$ 10-20 billion per year to be raised from direct budgetary support – one measure of how challenging the target is. If the carbon price were higher, the financial flows would be higher. The HLAG argues that its low and central carbon price assumptions are broadly consistent with the emission reduction pledges made so far under the Copenhagen Accord, while its ‘high’ carbon price assumption (up to US\$ 50 per tonne) is more consistent with keeping the increase in global temperature to 2°C. Hence if governments collectively take seriously their support for the 2°C limit, the challenge should be somewhat easier to meet.<sup>22</sup>

## **6. CONCLUSIONS**

There is a reassuring level of agreement among international policy-makers that developed countries should help finance climate change actions in developing countries, despite the range of ethical frameworks that are brought to bear in negotiations. The Copenhagen Accord’s target of raising US\$ 100 billion dollars a year by 2020 is modest relative to developing countries’ probable needs. The report of the UN Secretary-General’s High-Level Advisory Group on Climate Change Financing plausibly suggests that generating US\$ 100 billion is challenging but feasible, if a variety of measures are taken to stimulate private and public flows of finance. Developing countries’ needs must be kept under review as understanding of

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<sup>22</sup> Of course, more aggressive mitigation and higher carbon prices would also warrant more action by developing countries and more finance from developed nations. It is not clear whether policy-makers see the US\$ 100 billion target as consistent with the needs of developing countries in a world that takes the 2°C limit seriously.

the relevant science, economics and ethical considerations improves. So should the contribution to be made by developed countries. But this article has focused on the principles that should guide efforts to raise finance rather than how much should be raised and for what uses.

The main conclusions are:

- There is an important role for private finance. The key incentive is to have pervasive and broadly uniform emissions pricing around the world. Public authorities can stimulate private finance by helping to manage the risks of investing in mitigation, adaptation and technological innovation. Building the credibility of the long-term international climate policy framework is one of the main challenges in this regard. Private finance will be particularly important for adaptation, as the latter will depend to a greater extent on private decision-makers. And, within the right framework, it may be less subject to the vagaries of political popularity than public finance flows would be.
- Public finance is warranted by a range of market – and policy – failures associated with climate change and its mitigation. As well as the central environmental externality imposed by GHGs, there are problems in stimulating innovation, establishing infrastructure networks and overcoming barriers to financial intermediation. That is particularly the case while the long-term outlook for climate policy is still unclear to prospective private investors and, because of the world economic slowdown, the short-term outlook for returns on any investment is poorer than usual.
- Raising tax revenues may be preferable to borrowing as a means of raising public finance, although the economics is not clear-cut. The current budget worries of

many developed countries tip the balance further (although the pace of fiscal retrenchment necessary is subject to robust debate), but the need to build policy credibility points in the opposite direction. Theory also advocates taxing ‘bads,’ of which a number have escaped the tax base so far. But it discourages hypothecation of specific revenue streams to particular uses.

- There is a plethora of ideas and proposals for old and new forms of finance for climate action in developing countries. How much could or should be raised is very uncertain in most cases. So is how multiple schemes would interact. Several could have untoward consequences for emissions prices. Hypothecation is a frequent feature, with very little discussion of whether it is warranted. In many cases, it is clearly not warranted.
- Two sets of proposals do particularly well judged against this analysis: (i) expanding the scale and scope of the CDM (ii) expanding the use of international financial institutions’ balance sheets, including the use of SDRs. But, in both cases, governance arrangements are subject to controversy. There are a number of other proposals for new taxes that have merit as far as revenue generation is concerned but the case for earmarking the revenue raised for climate-change finance is not wholly compelling, resting as it does on the supposed benefits of pre-commitment by developed-country governments rather than a quantitative assessment of developing countries’ needs..

It is to be hoped that governments will act speedily to fulfil the promises of the Copenhagen Accord but without neglecting the principles of public finance in the process.

## REFERENCES

- Atkinson, A.B. (2004): 'New sources of development finance: funding the Millennium Development Goals', Policy Brief No. 10, UNU-WIDER, September
- Atkinson, A.B., and J.E. Stiglitz (1980): *Lectures in Public Economics*, McGraw Hill, New York
- Baker, D. (2008): *The benefits of a financial transactions tax*, Center for Economic and Policy Research, Washington D.C., December
- Blanchard, O.J., and F. Giavazzi (2004): 'Improving the SGP through a proper accounting of public investment', CEPR Discussion Paper No. 4220, February
- Bovenberg, L., and L. Goulder (2002): 'Environmental taxation and regulation', Chapter 23 in the *Handbook of Public Economics*, Vol. 3, edited by Auerbach, A., and M. Feldstein, Elsevier BV, Amsterdam
- Bowen, A. and N. Ranger (2009): 'Mitigating climate change with reductions in greenhouse gas emissions: economic assessment of emissions targets', Chapter 3 in 'Mitigating climate change through reductions in greenhouse gas emissions: the science and economics of future paths for global annual emissions,' Policy Brief, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, December
- Bowen, A. and N. Stern (2010): 'Environmental policy and the economic downturn', *Oxford Review of Economic Policy*, Vol. 26, No.2, pages 137-163
- Bret, C. and M. Keen (2000): 'Political uncertainty and the earmarking of environmental taxes', *Journal of Public Economics*, Vol. 75, No.3, pages 315-340
- Center for Clean Air Policy (2009): *Norway's proposal to auction Assigned Amount Units: implementation options*, CCAP, Washington D.C.
- Clarke, L., J. Edmonds, V. Krey, R. Richels, S. Rose and M.Tavoni (2009): 'International climate policy architectures: overview of the EMF 22 international scenarios', *Energy Economics*, Vol. 31, pages S64-S81
- Dietz, S., C. Hepburn and N. Stern (2009): 'Economics, ethics and climate change', in Basu, K., and R. Kanbur (ed.): *Arguments for a Better World: Essays in Honour of Amartya Sen (Volume 2: Society, Institutions and Development)*, Oxford University Press, Oxford
- European Commission (2008): *Environment Policy Review 2008*, European Commission, Brussels
- European Commission (2010a): *Taxation Trends in the European Union 2010*, European Commission, Brussels
- European Commission (2010b): 'International climate policy post-Copenhagen: acting now to reinvigorate global action on climate change', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels
- Faber, J., A. Markowska, V. Eyring, I. Cionni and E. Selstad (2010): *A global maritime emissions trading system*, CE Delft, Delft, January
- Fankhauser, S., and N. Martin (2010): 'The economics of the CDM levy: Revenue potential, tax incidence and distortionary effects', *Energy Policy*, Vol. 38, pages 357-363
- Frankel, J.A. (2009): 'An elaborated global climate policy architecture: specific formulas and emission targets for all countries in all decades', NBER Working Paper No. 14876, Cambridge, Massachusetts, April
- Green Investment Bank Commission (2010): *Unlocking investment to deliver Britain's low carbon future*, GIBC, London, June

Hanke, M., J. Huber, M. Kirchler and M. Sutter (2010): 'The economic consequences of a Tobin tax – an experimental analysis', *Journal of Economic Behavior and Organization*, Vol. 74, pages 58-71

Hepburn, C. (2009): 'Climates of change: sustainability challenges for enterprises,' Smith School Working Paper, University of Oxford, September

Höhne, N., D. Phylipsen, S. Ullrich and K. Blok (2005): *Options for the second commitment period of the Kyoto Protocol*, prepared by Ecofys for the Federal Environmental Agency, Berlin, February

IMF (2010): 'Financing the response to climate change', IMF Staff Position Note 2010/06, Washington D.C., March

IMO (2009): *The second IMO GHG Study 2009*, International Maritime Organization, London

Ismihan, M. and G. Ozkan (2008): 'Golden Rule of public finance: a panacea?' Discussion Paper in Economics No. 2008/19, Department of Economics and Related Studies, University of York

Kay, J.A. (1990): 'Tax policy: a survey', *Economic Journal*, Vol. 100, No. 399, pages 18-75

Keen, M. and J. Strand (2007): 'Indirect taxes on international aviation', *Fiscal Studies*, Vol. 28, pages 1-41

Landau, J.-P. (2003): *The Landau Report*, available at [http://www.cttcampaigns.info/documents/fr/landau\\_en/Landau1.pdf](http://www.cttcampaigns.info/documents/fr/landau_en/Landau1.pdf)

McCleary, W. (1991): 'The earmarking of government revenue. A review of some World Bank experience', *The World Bank Research Observer*, Vol. 6, pages 81-104

Metcalfe, G.E. (2009): 'Cost containment in climate change policy: alternative approaches to mitigating price volatility', NBER Working Paper No. 15125, Cambridge, Massachusetts, July

Müller, B. (2008): 'To earmark or not to earmark?' Oxford Institute for Energy Studies EV43, November

Müller, B. and C. Hepburn (2006): 'IATAL – an outline proposal for an International Air Travel Adaptation Levy', Oxford Institute for Energy Studies EV36, October

Musgrave, R.A., and P.B. Musgrave (1989): *Public finance in theory and practice*, McGraw Hill, New York

Nordhaus, W.D. (2007): 'To tax or not to tax: alternative approaches to slowing global warming', *Review of Environmental Economics and Policy*, Vol. 1, No.1, pages 26-44

ODI (2008): *Innovative carbon-based funding for adaptation*, Overseas Development Institute, London, November

OECD (1996): *Implementation strategies for environmental taxes*, OECD, Paris

Oxfam (2008): 'Turning carbon into gold', Oxfam Briefing Paper No. 123, Oxfam International, December

Parry, M., N. Arnell, P. Berry, D. Dodman, S. Fankhauser, C. Hope, S. Kovats, R. Nicholls, D. Satterthwaite, R. Tiffin and T. Wheeler (2009): *Assessing the costs of adaptation to climate change: a review of the UNFCCC and other recent estimates*, International Institute for Environment and Development, August

Pirttilä, J. (1998): 'Earmarking of environmental taxes: efficient, after all', Bank of Finland Discussion Paper 4/98, Helsinki

Pigou, A. (1932): *The Economics of Welfare*, 4th edition, MacMillan, London

Saporta, V., and K. Kan (1997): 'The effects of stamp duty on the level and volatility of equity prices', Bank of England Working Paper No 71, London, October

- Schneider, L. (2007): 'Is the CDM fulfilling its environmental and sustainable development objectives? An evaluation of the CDM and options for improvement', Report for WWF, Okö-Institut, Berlin, November
- Schöb, R. (2003): 'The double dividend hypothesis of environmental taxes: a survey,' CESIFO Working Paper No. 946, Munich, May
- Schulmeister, S. (2009): 'A general financial transaction tax: a short cut of the pros, the cons and a proposal', WIFO Working Paper No. 344, Vienna, October
- Schulmeister, S., M. Scratzenstaller and O. Picek (2008): *A general financial transaction tax: motives, revenues, feasibility and effects*, WIFO, Vienna, October
- Sinn, H.-W. (2008): 'Public policies against global warming'. *International Tax and Public Finance*, Vol. 15, pages 360-394
- Stern, N. (2009): *A blueprint for a safer planet: how to manage climate change and create a new era of progress and prosperity*, The Bodley Head, London
- Swiss Confederation (2008): *Funding scheme for Bali Action Plan: a Swiss proposal for global solidarity in financing adaptation*, Berne, May
- Tuerk, A., D. Frieden, M. Sharmina, H. Schreiber and D. Ürge-Vorsatz (2010): *Green Investment Schemes: first experiences and lessons learned*, Joanneum Research Working Paper, April
- Varian, H. (2009): *Intermediate microeconomics: a modern approach*, W.W. Norton & Co., 8<sup>th</sup> edition, New York
- Williamson, J. (2009): 'Understanding Special Drawing Rights (SDRs)', Policy Brief 09/11, Petersen Institute for International Economics, June
- World Bank (2009): *World Development Report 2010*, World Bank, Washington D.C.
- WRI (2008): *Financing adaptation: opportunities for innovation and experimentation*, WRI Conference Paper, Washington D.C., November